Physics 131 HW III – Solutions

1. $v(t) = at + v_0 = \left(-10\,\text{m}/\text{s}^2\right)\cdot t + v_0$

If $v_0 = 20\,\text{m/s}$, we'd guess at $-10\,\text{m/s}^2$ accel, it will take 2 sec to stop. We can check this by:

$$0 = at + v_0 = \left(-10\,\text{m}/\text{s}^2\right)t + 20\,\text{m/s} \Rightarrow 10\,\text{m}/\text{s}^2 \cdot t = 20\,\text{m/s}$$

$$\boxed{t = 2\,\text{sec}}$$

a is a constant for freefall – even at the top of the motion where $v=0$. a is the <u>slope</u> of the $v(t)$ graph – <u>not</u> the value

2. – $v=0$, but a is not zero: Problem 1 is one example, so is an object oscillating under a spring force at maximum displacement (i.e. when turning around).
– $a=0$, but $v \neq 0$. This occurs when an object has a constant velocity – such as a car on cruise control. Also, an oscillating object passing through the equilibrium point. There are many possible examples of each case

3. $.7\,\text{m}/\text{s}^2$, $v_0 = 0$, how long to roll 500 m?

$$\Delta x = \tfrac{1}{2}at^2 + \cancel{v_0 t}^{\,0}, \text{ so } t^2 = \frac{2\Delta x}{a}$$

$$\text{or } t = \sqrt{\frac{2\cdot 500\,\text{m}}{.7\,\text{m}/\text{s}^2}} =$$

4. $x(t) = x_f - \frac{m v_0}{\alpha} e^{-\frac{\alpha}{m}t} \Rightarrow$ find $v(t)$

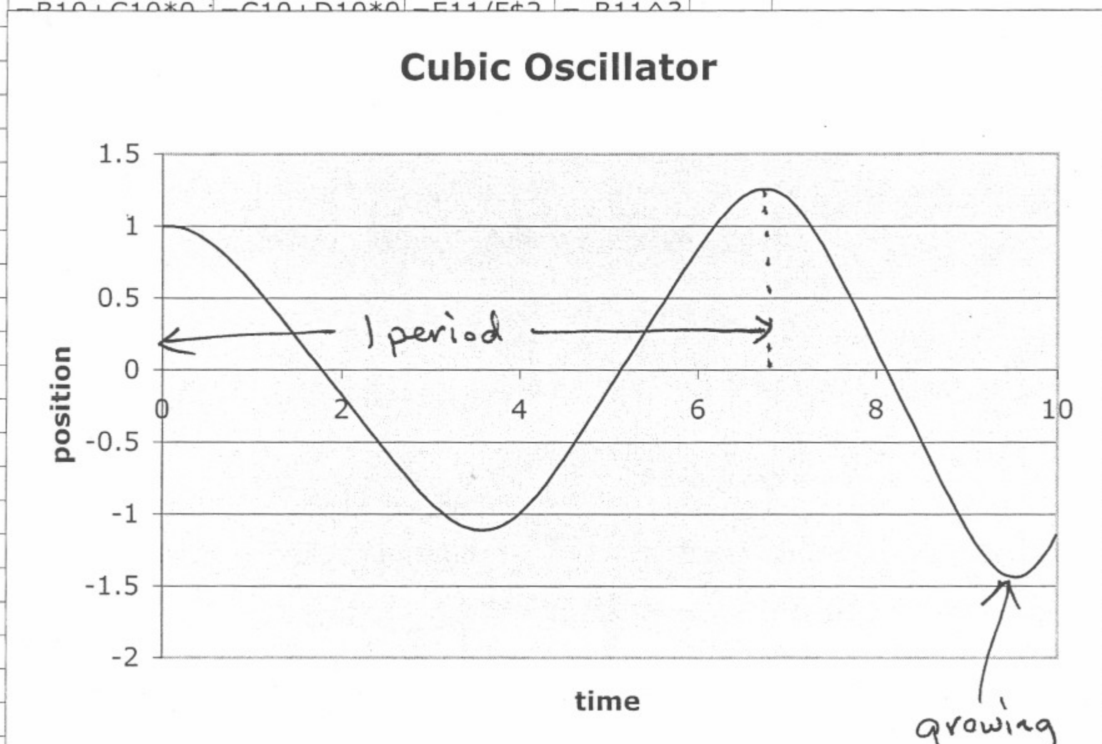
$$v = \frac{dx}{dt} = 0 - \left(-\frac{\alpha}{m}\right)\frac{m v_0}{\alpha} e^{-\frac{\alpha}{m}t} = v_0 e^{-\frac{\alpha}{m}t}$$

which is the form we found in AG III.3

5 & 6 – see following printout

Problem # 5 – HW III

time	position	velocity	acceleratio	Force	Mass	
0	1	0	=E2/F$2	=-B2^3	1	
0.1	=B2+C2*0.1	=C2+D2*0.1	=E3/F$2	=-B3^3		
0.2	=B3+C3*0.1	=C3+D3*0.1	=E4/F$2	=-B4^3		
0.3	=B4+C4*0.1	=C4+D4*0.1	=E5/F$2	=-B5^3		
0.4	=B5+C5*0.1	=C5+D5*0.1	=E6/F$2	=-B6^3		
0.5	=B6+C6*0.1	=C6+D6*0.1	=E7/F$2	=-B7^3		
0.6	=B7+C7*0.1	=C7+D7*0.1	=E8/F$2	=-B8^3		
0.7	=B8+C8*0.1	=C8+D8*0.1	=E9/F$2	=-B9^3		
0.8	=B9+C9*0.1	=C9+D9*0.1	=E10/F$2	=-B10^3		
0.9	=B10+C10*0.	=C10+D10*0	=E11/F$2	=-B11^3		
1						
1.1						
1.2						
1.3						
1.4						
1.5						
1.6						
1.7						
1.8						
1.9						
2						
2.1						
2.2						
2.3						
2.4						
2.5						
2.6						
2.7						
2.8						
2.9						
3						
3.1	=B32+C32*0.	=C32+D32*0	=E33/F$2	=-B33^3		
3.2	=B33+C33*0.1	=C33+D33*0	=E34/F$2	=-B34^3		
3.3	=B34+C34*0.1	=C34+D34*0	=E35/F$2	=-B35^3		
3.4	=B35+C35*0.1	=C35+D35*0	=E36/F$2	=-B36^3		
3.5	=B36+C36*0.1	=C36+D36*0	=E37/F$2	=-B37^3		
3.6	=B37+C37*0.1	=C37+D37*0	=E38/F$2	=-B38^3		
3.7	=B38+C38*0.1	=C38+D38*0	=E39/F$2	=-B39^3		
3.8	=B39+C39*0.1	=C39+D39*0	=E40/F$2	=-B40^3		
3.9	=B40+C40*0.1	=C40+D40*0	=E41/F$2	=-B41^3		
4	=B41+C41*0.1	=C41+D41*0	=E42/F$2	=-B42^3		
4.1	=B42+C42*0.1	=C42+D42*0	=E43/F$2	=-B43^3		
4.2	=B43+C43*0.1	=C43+D43*0	=E44/F$2	=-B44^3		
4.3	=B44+C44*0.1	=C44+D44*0	=E45/F$2	=-B45^3		
4.4	=B45+C45*0.1	=C45+D45*0	=E46/F$2	=-B46^3		
4.5	=B46+C46*0.1	=C46+D46*0	=E47/F$2	=-B47^3		
4.6	=B47+C47*0.1	=C47+D47*0	=E48/F$2	=-B48^3		
4.7	=B48+C48*0.1	=C48+D48*0	=E49/F$2	=-B49^3		

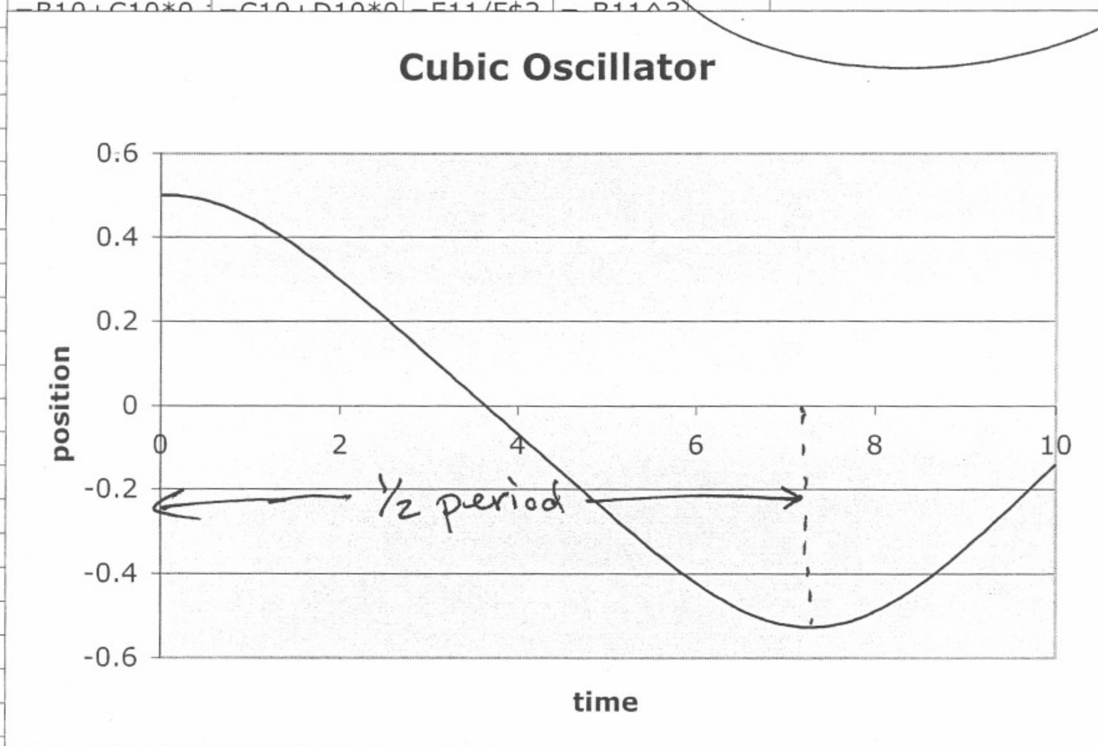


growing amplitude is a result of our numerical approximation – not real!

problem # 6 HW III

time	position	velocity	acceleratio	Force	Mass
0	0.5	0	=E2/F$2	=-B2^3	1
0.1	=B2+C2*0.1	=C2+D2*0.1	=E3/F$2	=-B3^3	
0.2	=B3+C3*0.1	=C3+D3*0.1	=E4/F$2	=-B4^3	
0.3	=B4+C4*0.1	=C4+D4*0.1	=E5/F$2	=-B5^3	
0.4	=B5+C5*0.1	=C5+D5*0.1	=E6/F$2	=-B6^3	
0.5	=B6+C6*0.1	=C6+D6*0.1	=E7/F$2	=-B7^3	
0.6	=B7+C7*0.1	=C7+D7*0.1	=E8/F$2	=-B8^3	
0.7	=B8+C8*0.1	=C8+D8*0.1	=E9/F$2	=-B9^3	
0.8	=B9+C9*0.1	=C9+D9*0.1	=E10/F$2	=-B10^3	
0.9	=B10+C10*0.	=C10+D10*0	=E11/F$2	=-B11^3	
1					
1.1					
1.2					
1.3					
1.4					
1.5					
1.6					
1.7					
1.8					
1.9					
2					
2.1					
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3					
3.1	=B32+C32*0.1	=C32+D32*0	=E33/F$2	=-B33^3	
3.2	=B33+C33*0.1	=C33+D33*0	=E34/F$2	=-B34^3	
3.3	=B34+C34*0.1	=C34+D34*0	=E35/F$2	=-B35^3	
3.4	=B35+C35*0.1	=C35+D35*0	=E36/F$2	=-B36^3	
3.5	=B36+C36*0.1	=C36+D36*0	=E37/F$2	=-B37^3	
3.6	=B37+C37*0.1	=C37+D37*0	=E38/F$2	=-B38^3	
3.7	=B38+C38*0.1	=C38+D38*0	=E39/F$2	=-B39^3	
3.8	=B39+C39*0.1	=C39+D39*0	=E40/F$2	=-B40^3	
3.9	=B40+C40*0.1	=C40+D40*0	=E41/F$2	=-B41^3	
4	=B41+C41*0.1	=C41+D41*0	=E42/F$2	=-B42^3	
4.1	=B42+C42*0.1	=C42+D42*0	=E43/F$2	=-B43^3	
4.2	=B43+C43*0.1	=C43+D43*0	=E44/F$2	=-B44^3	
4.3	=B44+C44*0.1	=C44+D44*0	=E45/F$2	=-B45^3	
4.4	=B45+C45*0.1	=C45+D45*0	=E46/F$2	=-B46^3	
4.5	=B46+C46*0.1	=C46+D46*0	=E47/F$2	=-B47^3	
4.6	=B47+C47*0.1	=C47+D47*0	=E48/F$2	=-B48^3	
4.7	=B48+C48*0.1	=C48+D48*0	=E49/F$2	=-B49^3	

With amplitude cut in half, we go from a period of about 7 to a period of about 14. (see prev. page)



7. $P_{before} = P_{after}$

$$m_{ball} v_{ball_{bef}} + m_{pin} \cancel{v_{pin_{bef}}}^{\,0} = m_{ball} v_{ball_{aft}} + m_{pin} v_{pin_{aft}}$$

$$4kg \cdot 4m/s + 0 = 4kg \cdot v_{ball_{aft}} + 1kg \cdot 5\,m/s$$

$$16\,kg\,m/s = 4kg \cdot v_{ball_{aft}} + 5\,kg\,m/s$$

$$11\,kg\,m/s = 4kg \cdot v_{ball_{aft}}$$

$$\frac{11\,kg\,m/s}{4kg} = v_{ball_{aft}} = \boxed{2.75\,m/sec}$$

So, ball slowed by $\boxed{1.25\,m/sec} = \Delta v_{ball}$

8. $P_{bef} = P_{aft}$

$$m_1 v_{1b} + m_2 v_{2b} = m_1 v_{1a} + m_2 v_{2a}$$

$$800kg \cdot 20\,m/s + 600kg \cdot 5\,m/s = 800kg\, v_{1a} + 600\,kg\, v_{2a} = 1400kg \cdot v_a$$

same veloc

$$(16000 + 3000)\,kg\,m/s = 1400\,kg \cdot v_a$$

$$v_a = \frac{19000\,kg\,m/s}{1400kg} = \boxed{13.6\,m/sec}$$